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VALUES IN CLASSIFICATION OF THE STAGES OF GROWTH AND DECLINE, WITH PROPOSITIONS FOR A NEW NOMENCLATURE.[1]

BY ALPHEUS HYATT.

IN accord with views brought to the notice of the society in 1884, under the title of the "Larval Theory of the Origin of Tissue,"[2] an abstract of which was subsequently printed in *Amer. Journ. Sci.* May 31, 1886, we divide the animal kingdom into three comprehensive divisions: (1) PROTOZOA, unicellular animals, which propagate by means of asexual (autotemnic) fission and by spores, and build up colonies, but always remain typically unicellular. (2) MESOZOA, multicellular colonies, but composed of only one layer of cells, so closely connected, that they may be called a primitive tissue, and having more or less spherical forms.[3] They propagate by means of ova, spermatozoa, and by autotemnic fission,[4] and have an aula or common cavity, but no specialized digestive cavity or archenteron. (3) METAZOA, complexes of multicellular colonies, in which growth by sexual union, and resulting fission of the ovum, forms three primitive tissue layers and builds up a body in which an archenteron is always developed. They propagate always by means of ova and spermatozoa, autotemnic fission occurring only, if at all, during the earliest stages of the ovum. Holoblastic ova may be regarded as the more primitive or generalized forms to which all other forms of ova having more or less specialized and concentrated modes of development may be referred as derivatives. The stages of holoblastic ova may be in a general way classified as follows, to accord with that given above for the Animal Kingdom :—

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[1] Abstract of a paper read at the meeting of the Bost. Soc. Nat. Hist., Nov. 16, 1887. Vol. xxiii.

[2] Proc. Bost. Soc. Nat. Hist., vol. xxiii., 1884, p. 45.

[3] See Butschli's remark that the closely appressed hexagonal cells of the envelope are connected with each other by threads of propaplasm. Bronn. Thierreichs, vol. i. Protoz., p. 775.

[4] The best summary of all observations is in the work just quoted, where Butschli calls the sexual cells ova and spermatophora, but alludes to the cells developing by autotemnic fission as Parthenogonidia. They are by his own descriptions and those of others, ova, which differ from sexualized ova only in their ability to develop through autotemni fission.

(1) The ovum or Monoplast (Lankester); (2) the first stage of segmentation, which normally results in the production of two cells in the same place originated by vertical fission, the Monoplacula; (3) the second stage of segmentation in which two layers arise, the Diploplacula. The first two stages alone seem to have parallel or representative adult forms among Protozoa. The differentiation into esoteric, primitive ectoblast, and enteric, primitive endoblast cells takes place in the Diploplacula, and the morphological equivalent of this stage of the ovum, having an upper layer of differentiated feeding cells, has not yet been found among the adults of the Protozoa; though, if this is correct, such a discovery may be reasonably anticipated. We have proposed to classify these stages under the name of Protembryo.

(4) The Blastula is in aspect and general characteristics the morphological equivalent of the adults of the genera Volvox and Eudorina, the types of the Mesozoa or Blastrea. The latter are animals in which growth remained permanently arrested at the single-layered, spherical stage in the evolution of tissue-building forms. We have proposed to classify these stages under the name of Mesembryo.

(5) The Gastrula can be compared, as has been done by Hæckel, with the lower Porifera (Ascones), but these have three layers like the lowest Hydrozoa, in which a three-layered gastrula-like stage has been permanently preserved.[1] The proper name for these stages would therefore be Metembryo, in allusion to the fact that the ovum at this stage is probably essentially a Metazoon.

(6) The first and simpler Planula stages, though often character-

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[1] The true two-layered Gastrea type of Hæckel has, therefore, not been discovered. Doubtless, some such animals bringing the gap in the line of graded modifications between three-layered Ascones and single-layered Volvox will yet make their appearance, but we cannot consider any of the animals heretofore described as filling this gap to be entitled to such a position. They have all proved to be either three-layered, or else to belong to the true Mesozoa or Protozoa. See also for remarks on the prevalence of the three layers even in the gastrula, Metschnikoff, "Ueber gastrula einiger Metazoen" Zeitz. Wissen. Zool., V. 27, 1882, p. 305.

istic of the larger divisions of the Animal Kingdom, would not, if arrested at this period, be recognized as belonging to the same groups as their existing adults. They do not possess, as a rule, the essential diagnostic characters of the larger divisions to which they belong, and we propose to call them Neoembryos. Examples: the Cinctoplanula is not a sponge, the Planula of the Coelenterata is not a Cœlenterate, nor the Pluteus an Echinoderm, nor the Trochosphere a Mollusc, nor the Pilidium a Nemertean worm, nor the earliest planula-like ciliated stages of Amphioxus a Vertebrate. Neoembryos are, as pointed out by Semper,[1] Lankester [2] and Balfour,[3] so similar, that they may be considered as indicating a common ancestor for the entire Animal Kingdom.

(7) The latest of the more specialized planula-like stages are either directly transformed into, or else give rise to other forms in which the characters of the larger subdivisions or types of the Animal Kingdom begin to appear, at least so far as essential characters are concerned. Examples: the Ascula and Ampullinula are true sponges, the Actinula is a Hydrozoon, the Gulinula is an Actinozoon, the Veliger is a Mollusc, the internal worm-like form arising in Pilidium is a true Nemertean, the formation of the notochord in Amphioxus makes the planula-like embryo into a vertebrate animal. They have the essential characters of the larger subdivisions, though it is equally true, that embryos in this stage of development are very remote, in some cases, from the adults of any normal forms. We do not, therefore, misinterpret these relations by naming the embryo in these last stages the Typembryo. This term can be applied to the Nauplius of Crustacea, and the Echinula[4] of Echinodermata, as well as to those above noted.

[1] Semper, Stammsver, Wirbel. und Wirbello., Arbeit. Zoolog. Zootom Inst., V. ii., p. 59, and V. iii., p. 384. This distinguished author states in Volume iii., that his "Trochosphaera" is identical with the "ungegliderte Urnierenthier" which in his first table in Volume ii., appeared as the common ancestor of the higher animals, *i.e.*, of all animals except Echinodermata and Cœlenterata.

[2] Lankester traced the Mollusca, Annelida, Rotifera and Echinodermata to what he calls the Architroch, a common form taken from some what earlier stages of the Planula than those selected by Semper for his Trochosphaera. Embryol. and Classif. Journ. Micros. Sci., vol. xvii., 1877, p. 423.

[3] Balfour, Comp. Embryol., vol. ii., p. 311.

[4] Alexander Agassiz, Address, Am. Ass. Adv. Sci., V. 29, 1880, p. 410, shows that there is a stage of the embryo common to all orders of living

Typembryos serve to connect the earlier stages of the Neoembryos with the true larval stages which succeeded the former. Balfour and other embryologists have used the term "larva" for free neoembryos and typembryos. This term should be confined to the designation of stages of growth which are immediately continuous with later stages and parallel, or referable in their origin to the adults of allied, existing, or fossil forms, which are not so remote as those from which the embryonic stages were derived.

The application of such principles to the study of the younger stages of fossil Cephalopoda is productive of what seem to be satisfactory results. The protoconch of Owen is, according to this nomenclature, the shell of the univalve veliger of the Cephalous Mollusca, and a true typembryo which, though eminently characteristic of that group, has no exact morphological equivalent among adults of normal forms whether recent or fossil.

The protoconch in fossil Nautiloidea is represented by a withered-looking lump sticking to the apex of the conch in a very few exceptionally perfect specimens. The very general absence of this lump and the presence of a scar left by its removal on the apex of the conch, and the wrinkled, shrunken aspect of the lump when preserved, indicate the protoconch to have had a horny texture in this order. This typembryo shell must have existed among Nautiloids with an almost unchanged aspect from the earliest Cambrian (Lower Silurian) horizon until the present day, and its adult equivalent probably existed before its appearance in Cephalopoda or in the equally ancient and allied group of the Pteropoda, which also had similar protoconchs.

The true larval, or as they are here named, Silphologic[1] stages, began with the formation of what Owen has appropriately called the apex of the conch or true shell. Among Nautiloids this was a short living chamber occupied by the body of the animal, but having no

Echinodermata. This stage, however, was not named in the address above quoted, which was intended as preliminary to an illustrated essay on the same subject, and Mr. Agassiz has supplied that omission in the following note, which I quote from a letter to me. " I intended sometime when revising my ' Address on Palæontological and Embryological, Development,' to call the earliest common stage of echinoderm embryos ' Echinula' for convenience in making comparisons.—A. Agassiz.'

[1] Σίλφη, a grub.

siphon or septum. It was completed by the deposition of the apical plate, which sealed up the aperture of the protoconch thus closing the opening and cutting off communication between the two interiors.

This stage can therefore be named the asiphonula or siphonless larva. The apex of this conch was rounded, being built out in concentric circles from the contracted aperture of the protoconch, probably before this was plugged up by the deposition of the apical plate. The asiphonula was not a Cephalopod, since it had no central siphon, nor even a septum. It may have resembled more or less closely the adults of some of the ancient Pteropoda. Von Jhering has thought, that the characteristics of the early stages of Ammonoids justified a comparison between them and forms of Pteropoda having similar protoconchs. This was our own position also, but we now see, that the asiphonula was not necessarily a wholly pteropod-like animal. It may have retained many of the veliger's characteristics, and may have more or less resembled a generalized type to which a Scaphopod is the nearest living approximation. Prof. W. K. Brooks' opinion, that the Scaphopods are such a generalized type and that the veliger has characters which can be compared with those of the adult of Dentalium ought at any rate to be considered here.

It is not at all improbable, that the Pteropoda may never have served as radicals for the Nautiloids or Ammonoids, but the latter may have sprung directly from the ancient Scaphopoda.

The cicatrix naturally suggests comparison with the posterior opening in the shell of Dentalium, but if our view is the true one, and it represents the aperture of a protoconch, no such comparison can be made. The development of the conch in Dentalium is, according to Lacaze Duthier's researches, directly continuous with that of the protoconch, and the posterior opening is the result of the peculiar mode of growth of a primitive plate of shell which is never closed up. The shell, in other words, is a *periconch* growing around the body in the veliger and finally coalescing to form a tube open at both ends.

The second larval stage in Nautiloidea was composed of a living chamber closed apically and completed by a single septum, which had a cæcal prolongation reaching across the first air chamber and

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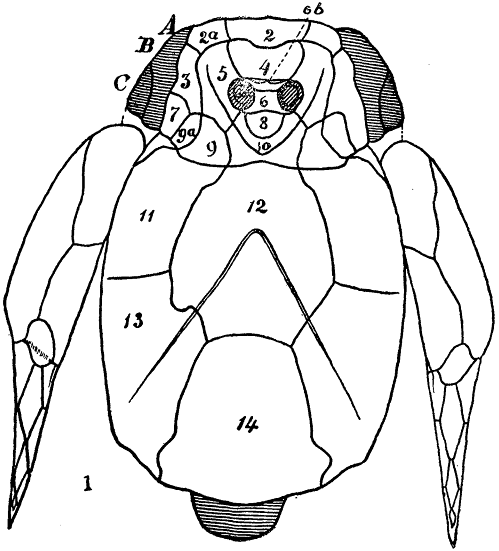
[1] Proc. Bost. Soc. Nat. Hist., Aff. Moll. and Molluscoid., V. 18, 1876.

PLATE XV.



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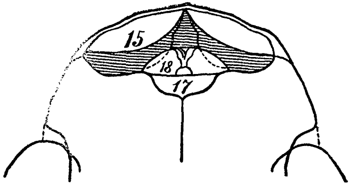

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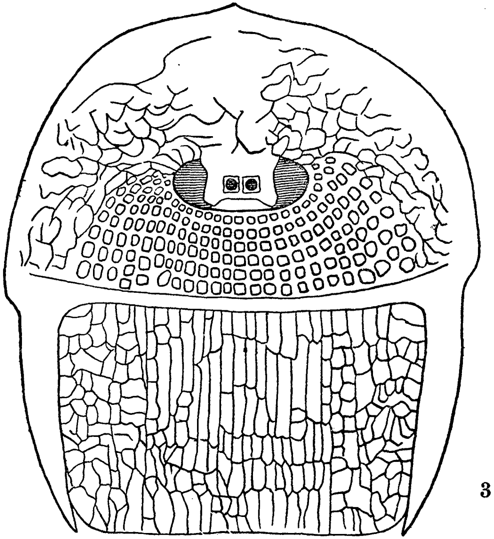

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Fig. 1. Shell of *Bothriolepis canadensis* Whiteaves, from above. (From Whiteaves.)
Fig. 2. Anterior part of same from above. (From Whiteaves.)
Fig. 3. Skull of *Mycterops ordinatus* Cope, from below, $\frac{2}{3}$ natural size.

resting upon the inner side of the scar. It is proposed to call this stage the Cæcosiphonula, since it is undoubtedly the primitive stage of that organ. The cæcosiphonula may indicate the former existence of an ancestral form having a central axis composed of similar closed funnels or cæcal pouches.[1]

The third Silphologic stage in Nautiloids was completed by a septum (the second in the apical part of the shell) having an open funnel extending apically and joined to a loose textured siphonal wall which reached down into and lined the cæcum, thus forming a secondary closed tube. In accordance with the structure this has been named the Macrosiphonula.

The protoconch was present in Ammonoids and also in Belemnoids, but in both of these orders it was calcareous. The tendency to form a calcareous shell, which first appeared in the apex of the conch of the asiphonula in Nautiloids, became by concentration of development inherited earlier in the Ammonoids and Belemnoids in the veliger stage, thus transforming what would otherwise have been a horny shell into a calcareous one. The protoconch was, however, not otherwise changed in external aspect and retained the usual egg-like shape of the univalve veligers of the Cephalophora. As in the protoconchs of other similar veligers of Gasteropoda, etc., and as a result of calcification, the protoconch became fused with the apex of the conch more intimately than in Nautiloids. In other words the asiphonula, after transmitting a portion of its characteristics to the typembryos of the Ammonoids and Belemnoids, disappeared, having been replaced by the Cæcosiphonula. The septum of the cæcosiphonula was consequently also inherited earlier, and became a functional substitute of the apical plate serving to close the aperture of the protoconch, and its cæcum extended into the upper part of the otherwise empty protoconch, in place of occupying the first air chamber as in Nautiloids. This is a remarkable example of the law of concentration, but by no means exceptional. The fourth larval stage of the Nautiloids was completed by the building of the third septum. This septum had a long funnel and attached porous wall, but the wall formed a true siphonal tube opening apically into the next section, the macrosiphon. This was the beginning of the small siphon and can be appropriately termed the Microsiphonula. The microsiphonula was the typical stage of nearly all the known genera of Nautiloids, beginning with the Orthoceratites of the Cambrian and found at the present time in Nautilus, and also in all Ammonoids and Belemnoids without exception.

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[1] See also similar remarks by Whitfield, Bull. Amer. Mus. New York, No. 1, and Embryol. Ceph. by the author, Bull. Mus. Comp. Zool., V. 3, No. 5, p. 100.

Fortunately the genesis of both macrosiphonula and microsiphonula can be traced in the adult forms and silphologic stages of well-known fossils. The Crytocerina had a siphon which was macrosiphonulate probably even in the adult stage, since it increases in diameter throughout life. Piloceras had a huge siphon hardly at all contracted in the adults of some species, but considerably lessened in diameter during the same stage in others. Endoceras had also a large siphon always more or less contracted in the silphologic or later stages. The uncontracted macrosiphonula occupied in this genus a number of air chambers varying according to the species, from a few to six or more. This was evidently due to the earlier inheritance or concentration of the tendency to decrease the diameter of the siphon first manifested in the adults of Piloceras. Sannionites was a genus in which the siphon was smaller than in Endoceras, and probably, though this is not yet ascertained, inherited the tendency to microsiphonulation at the first septum at an earlier age than in Endoceras. None of these forms, however, attained a true microsiphon, since even Sannionites had the siphon filled by endocones and in the centre an endosiphon. These organs entirely disappeared in true microsiphonulate forms and, in fact, could have existed only within a large macrosiphon.

Nevertheless this tendency to decrease the size of the siphon resulted in the formation of a definite constriction. This constriction was inherited at earlier and earlier stages after its origin in the siphon of Piloceras, until it became constant perhaps in Sannionites and certainly in the Orthoceratidæ. The constriction marked the line between the larger and smaller siphon in the macrosiphonulate forms, and, in becoming constant through concentration, it became invariably fixed behind the first septum between the cæcosiphonula and the smaller siphon. This smaller siphon, though still a macrosiphon in structure, as explained above, even in

Sannionites, was undoubtedly transitional to the true microsiphons of the Orthoceratidæ.

The cæcosiphonula was in all Orthoceratites, which are otherwise similar to Endoceras, confined by concentration of development to the first air chamber, and a true microsiphonula appeared at an early stage as an open narrow tube. This was similar to the siphon of the vast majority of all succeeding forms of both Nautiloids and Ammonoids. According to the classification here advocated, the stages preceding the microsiphonula, viz.: the asiphonula, cæcosiphonula and macrosiphonula, became silphologic stages in all the groups of Cephalopoda descending from the radical Endoceratidæ. Microsiphonulation became silphologic in the Orthoceratidæ, and the smooth shell which they evolved was subsequently inherited among Nautiloids, Ammonoids and Belemnoids during the younger stages in all the species of these orders. Other forms, with depressed and involved whorls, were introduced in the main stock of radicals among Goniatitinæ, and were modifications of the smooth cylinder of the simpler Orthoceratidæ with its microsiphon. These in turn became the proximal radicals of derivative groups. Thus the Anarcestes[1] among Goniatitinæ became the radicals of the Ammonoidea, and the smooth silphologic stages of all Ammonoids after the expiration of the Devonian were like the adults of these lowest forms of Goniatitinæ. This later acquired silphologic stage has therefore been styled the Goniatitinula.

It has also been found, that in tracing the descent of forms within smaller groups, sub-orders, families, and genera, it is practicable, as in the case of the family of Endoceratidæ, to prove that characteristics usually appear first in adult stages and are then inherited at earlier and earlier stages in successive species of the same stock, whether they occur on the same horizon, or in different horizons. The adolescent or Nealogic[2] stages are of as great importance for tracing the genealogy of small groups as are the silphologic characters in larger groups. Thus one can speak in definite terms of the relations of the nealogic stages, and their meaning and importance in tracing the genealogy of families and genera, without danger of confusing them with the characters of any of the silphologic stages.

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[1] Gen. Ceph. Proc. Bost. Soc. Nat. Hist., V. 22, 1880, p. 305.

[2] *Νεαλής*, youthfulness.

After the silphologic and nealogic stages have been disposed of there still remains the adult period, which is equally important in genealogical investigations, since it enables the observer to study the origin of many characters, which afterwards become silphologic and nealogic in descendent forms.

It is not uncommonly assumed, that adaptive characters appearing in embryos and larvæ are apt to be transient and have but little effect on the subsequent history of the early stage in the same group; also, that such characters have appeared just as readily in the larvæ as in adults. Up to the present time this has not been found to be true among fossil Cephalopoda, and there exist, so far as known to the author, but few characteristics probably originating in the early stages. The constant recurrence of hereditary characteristics in silphologic and nealogic stages which originated in adults, like those given above for the Endoceratidæ, makes the probability of the assumption, that the asiphonula and veliger represent the adult stages of lost types, so highly probable, that the burden of proof must rest upon the opponents of this argument. Each case of the origin of characters in embryo and larvæ should in other words be regarded with distrust until proven.

The appearance of the incomplete modes of segmentation in existing Sepioidea may possibly be a case of origination in embryo. There are no adult forms known to the author, which store up food in their tissues in such a manner that they can be used to explain the origin of the specialized food yolk. Nevertheless special inquiry might have very unexpected results. The case above given of the calcareous nature of the protoconch, and all the other characters of the stage in the Ammonoids and Belemnoids, seemed to have originated in embryo until it was found that a distinct silphologic stage, the asiphonula, existed in Nautiloids, and that this indicated the former existence of an asiphonulate ancestor having a calcareous shell.

Some of the characters of the goniatitinula, such as the deep ventral saddle of the first septum in the angustisellate young, as described by Branco, doubtless originated in the younger stages. These are, however, correlative with the anarcestian form of this stage and with a general tendency to closer involution, which acted the same way in every series of forms, whether we select series of adults or of embryos for comparison.

The use of a distinct term for the adult period becomes necessary not only on this account, and to separate its relations from those of preceding periods, but also because of the constant recurrence and importance of representative forms. The term Ephebology[1] has accordingly been adopted for the designation of the relations of the adult stages, and under this term can be classified also the representation of similar forms in different groups or morphological equivalents. These are often so exact that it becomes very difficult to separate them. They have been and will continue to be the most difficult and misleading obstacles to the student of genealogy and classification.

In former essays we have described and defined the senile transformations and their correlations with the degraded forms of the same groups. The nature of these relations is, as has been explained, quite distinct from those of the progressive and adult stages, but the correlations are nevertheless equally important for the classification and tracing of genealogies during the declining period of a group, and in the case of degraded and aberrant forms. We have, therefore, for some years past designated these relations by the term Geratology.[2]

This nomenclature is similar to that adopted by Hæckel, but is, when properly considered, also supplementary and based upon morphological rather than physiological grounds. This eminent author regarded the ontogeny of an individual to be divisible into three periods: first, the stages of Anaplasis or those of progressive evolution; second, the stages of fulfilled growth and development, Metaplasis; third, those of decline, Cataplasis. He also appreciated and gave full weight to the general physiological correlations which are traceable between the history of a group and the life of an individual, and, in accordance with these ideas, designated the progressive periods of expansion in the phylogenetic history of a group as the Epacme, the period of greatest expansion in number and variety of species and forms as the Acme, and the period of decline in numbers of species, etc., as the Paracme.

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[1] *Ἔφηβος*, the age of puberty.

[2] *Γέρας*, old age.

Hæckel used also the term Anaplastology for the physiological relations of the stages of progressive growth and those of the Epacme of groups, Metaplastology for those of the adult and the Acme of groups, and Cataplastology for those of the senile stages and the Paracme of group. These terms seem to cover the same ground, as those we have employed, but they were in reality chosen for the purpose of classifying physiological relations. Thus the anaplastic relations of the Embryologic, Silphologic and Nealogic stages to the phenomena occurring in the Epacme of groups, and the metaplastic relations of the Ephebolic stages to the phenomena occurring at the Acme of groups, and the cataplastic relations of the Geratologic stages to the phenomena occurring during the Paracme of groups, are the functional relations of one class of morphological modifications to those of another class and do not properly include the morphological phenomena themselves or their morphological correlations.

The necessity for a double set of terms may possibly not be at first admitted by many zoologists on account of their too exclusive devotion to the morphological side of their studies, but a very slight experience in trying to express the serial correlations of morphological and physiological phenomena will very soon show them, the convenience of such a nomenclature. Geologists have already arrived at this conclusion with regard to the classification of strata in the earth's crust and have begun to use two parallel series of terms, one giving the nomenclature of the relations in time, Era, Period, Age, etc., and the other the faunal relations under the headings of Group, System, Stage, and so on.[1] The time has come for recognizing a similar parallelism between structural or statical phenomena of organisms and their dynamical or physiological relations in time, and it is necessary to separate these clearly by different series of terms in order to see not only how they are separable, but also their correlations.

We have been more or less constantly observing and publishing on the Geratologic stages among fossil Cephalopoda for more than twenty years and have repeatedly described the more or less exact comparisons, which can be made between the different stages of decline in the individual and the degraded forms occurring in the same group.

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[1] G. K. Gilbert, Address, Am. Ass. Adv. Sci., 1887.

There were two stages in the old age period among Ammonoids: the first of these can be designated as the Clinologic[1] stage. This immediately succeeded the ephebolic period and during its continuance the nealogic and ephebolic characteristics underwent retrogression. Ornaments, spines, and sutures degenerated and lost their angularity, the ribs of pilæ, and often the keel and channels, when the latter were present, became less prominent, and before this stage closed the whorl itself sometimes decreased, showing that degeneration in the growth force of the animal had taken place. Similar phenomena can be easily observed in other departments of the animal kingdom, notably in man, whose habits tend to preserve life until he has attained extreme age. During this period there is a steady loss of the differential characters acquired during the stages of progressive growth and there is a tendency to resume the proportions and aspect of the earlier nealogic stages. In man, baldness of the head, loss of teeth and resorption of the alveoli, loss of the calves, rotund stomach, and the return of early mental peculiarities, are phenomena of similar import.

The last changes in the ontology of the animal may be termed the Nostologic stage,[2] and during this stage these tendencies reached their highest expression. Among Ammonoids the ornaments were all lost by resorption, the whorl became almost as round and smooth as it was in the silphologic stage, and in extreme cases it was separated from the next whorl, leaving a perceptible gap. This almost complete reversion to the aspect of the silphologic stage can of course only occur in animals which attain an extreme age.

The correlations of Clinology are exact, and indicate the changes which may be expected to occur in the same group whenever degraded or aberrent species can be traced in a more or less continuous series of graded modifications starting with any given normal form. Many such series have been traced, and these are recognized now by all palæontologists as genetically connected. They began with normal, close coiled, ornamented, shells, the descendants were smaller, showing a tendency to be less involved by growth, to lose their ornaments, and simplify the outlines of the sutures, though they had coiled young stages similar to those of the normal forms from which they must have originated.

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[1] *Κλίνω*, to incline downwards.

[2] *Νόστος*, a return.

The correlations of Nostology can only be artificially separated from those of Clinology, but there existed one class of forms which can be compared only with the nostologic stage. These are the degenerate straight Baculites-like shells, which belong to several distinct genetic series and should often be widely separated on that account. Their resemblances are undoubtedly close, but they are due to degeneration and, therefore, simply homoplastic. Naturalists sooner or later will begin to recognize that degeneration may produce close representation in forms having distinct origins. The Baculities is a smooth, straight, cylindrical though slightly compressed shell, which has so completely reverted that it resembles an Orthoceras, though it is an unquestionable Ammonoid of the Jura and Cretaceous.

THE POISON-APPARATUS OF THE MOSQUITO.

BY PROFESSOR G. MACLOSKIE.

THE oral armature or proboscis of the mosquito (*Culex*) is described and figured in Dimmock's *Mouth-parts of Some Diptera,* and consists of a labrum, two mandibles, two maxillæ, surrounding a hypopharynx, and all these enclosed in a loose scale-covered sheath, which is the labium. They are nearly three millimetres long, about four times as long as the head; and all except the sheath are smooth, chitinous stylets. The maxillæ bear maxillary palps, scaly, four-jointed, about as long as the head in *Culex,* and three times as long in the allied genus *Anopheles.* I have only to add to Dimmock's description that besides the somewhat coarse serration of the maxillæ (about fifteen teeth near the top of each), Minot S. Morgan, of Princeton, has shown very fine serrations on the upper part of the mandibles (about forty-two minute teeth on each).

The hypopharynx is in the axis of all these mouth parts, being inserted by a basal enlargement close behind the oral aperture, and